

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the Matter of)	
)	
Wireless E911 Location Accuracy)	PS Docket No. 07-114
Requirements)	

**REPLY COMMENTS OF
NEXTNAV, LLC**

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SUMMARY

Overwhelming support for the immediate adoption of a 3 meter vertical accuracy metric was expressed in comments filed by both the public safety community and the major wireless carriers. The comments also reflect the fact that a 3 meter metric has been validated as technically achievable. NextNav demonstrated better than 3 meter accuracy in the z-axis test bed and another vendor demonstrated in the same testbed that it could likely achieve accuracy within 3 meters in the future. Further, other vertical location technologies are under development that are expected to be able to provide vertical location information by April 2021. Therefore, the Commission should promptly adopt its proposed 3 meter metric and require wireless carriers to either implement this capability or a dispatchable location solution by the April 2021 and 2023 deadlines.

The Commission should not entertain calls to either delay the implementation of a vertical location requirement or adopt a less stringent metric that would not ensure the provision of ‘floor level’ accuracy to emergency first responders. The Commission should also reject APCO’s proposal to refrain from adopting any vertical location metric. The Commission’s rules currently reflect a flexible and technically neutral approach in which wireless carriers have the option between compliance with horizontal and vertical location requirements or a dispatchable location approach. It would be arbitrary and capricious to now withdraw one of the options for compliance. It would also be highly imprudent to eliminate the vertical location option given the very disappointing test results that were recently documented by ATIS for the dispatchable location approach using the National Emergency Address Database.

In adopting a 3 meter metric, the Commission should permit wireless carriers to demonstrate compliance in an independently administered test bed using 80% of all calls from z-axis capable handsets. As the Commission has acknowledged, most smartphones already include

barometric pressure sensors and many smartphones could be upgraded with calibration software as a part of an over-the-air upgrade of the operating software. To ensure the continued increase in deployment of such capabilities, the Commission may want to require that a certain percentage of handsets sold (or operating systems upgraded) for use on each carriers' network are z-axis capable.

The Commission should also require that vertical location information be reported to Public Safety Answering Points ("PSAPs") with a uniform confidence level of 90%. As APCO observed, confidence and uncertainty data is already required for horizontal location information and it should also be required for vertical location information.

In addition, the Commission should require that vertical location information be reported to PSAPs as a quantitative value expressed as height above ellipsoid ("HAE"). As numerous parties have explained, HAE is a globally accepted approach for reporting altitude that is already used for the global positioning system ("GPS"). The Commission should not require vertical location vendors to convert HAE into a floor level description because such capabilities do not yet exist that could be implemented on a reliable or consistent basis. Instead, the conversion of vertical location information from an objective statement of altitude to a descriptive indicator that is potentially unique to each building would introduce error and uncertainty that would ultimately harm the emergency first response process.

The Commission should further consider allowing wireless carriers to satisfy their vertical location obligations using 80% of buildings in excess of three stories in each of the top 25 and 50 cellular market areas rather than covering 80% of the population. The former approach would help to ensure that wireless carriers deploy their vertical location capabilities in the areas that will benefit most from the significant reductions in emergency response times that vertical location data can provide.

Finally, in adopting enhanced privacy rules for vertical location information, the Commission should impose restrictions only on the non-emergency use of vertical data that is generated by wireless handsets to support calls to E911 emergency services. In non-emergency situations, however, handset users should continue to have the option to permit their smartphones to use vertical location data to support other beneficial applications (such as mapping and personal fitness programs) if they desire, just as they do today with respect to location data produced by GPS and other means.

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NextNav, LLC (“NextNav”), by its attorneys, hereby replies to the comments that were filed in response to the Commission’s Fourth Further Notice of Proposed Rulemaking (“*Fourth FNPRM*”) proposing the adoption of a vertical accuracy metric of +/-3 meters to support emergency first responders.

I. OVERWHELMING SUPPORT EXISTS FOR THE PROMPT IMPLEMENTATION OF A 3 METER VERTICAL LOCATION METRIC

A critical mass of support has clearly emerged for the immediate adoption of a vertical location metric of +/-3 meters. Nearly every public safety organization that has been active on these issues favors the implementation of this metric, acknowledging that 3 meters “is a reasonable benchmark for locating the floor on which a caller is located”¹ and constitutes “an important step” toward achieving the accuracy necessary for emergency first responders “to provide lifesaving assistance in a safe and timely manner.”²

¹ Comments of NENA: the 9-1-1 Association, PS Docket No 07-114, at 1 (May 20, 2019) (“*NENA Comments*”).

² See Comments of The International Association of Chiefs of Police (IACP), the International Association of Fire Chiefs (IAFC), the National Association of State EMS Officials (NASEMSO), and the National Sheriffs’ Association, PS Docket No. 07-114, at 2 (May 20, 2019) (“*Public Safety Comments*”).

The public safety community has repeatedly emphasized that the “critical objective” of this proceeding is achieving “floor-level accuracy” and, from a practical perspective, “3-meter accuracy is floor level accuracy.”³ The public safety community has additionally observed that the Commission’s proposal to adopt a 3 meter metric is based on a “fair and reasonable assessment that the existing record supports adoption of the proposed 3-meter z-axis metric for 80 percent of CMRS calls” and the adoption of a more lenient metric “would not satisfy the critical requirements of public safety.”⁴

The nationwide wireless carriers have also coalesced around the adoption of a 3 meter vertical metric. AT&T expressed its support for 3 meters because it will “more accurately enable first responders to identify the floor level for most 911 calls, reduce emergency response times, and save lives.”⁵ AT&T further explained that a 3 meter metric “will give the industry certainty and advance the development process necessary to meet the 2021 and 2023 vertical location accuracy benchmarks in the *Fourth Report & Order*.”⁶

Verizon also expressed support for the 3 meter vertical metric, concluding that it would be “a good target for 9-1-1 calls from devices with the necessary capability.”⁷ CTIA also acknowledged that the 3 meter proposal “offers a reasoned approach to the definition of floor level

³ Comments of The Boulder Regional Emergency Telephone Service Authority (“BRETSA”), PS Docket No. 07-114, at unnumbered page 4 (May 20, 2019) (“*BRETSA Comments*”).

⁴ Initial Comments of the Texas 9-1-1 Entities, PS Docket No. 07-114, at 2 (May 20, 2019) (“*Texas 9-1-1 Entities Comments*”).

⁵ Comments of AT&T Services, Inc., PS Docket No. 07-114, at 1-2 (May 20, 2019) (“*AT&T Comments*”).

⁶ *Id.* at 2.

⁷ Comments of Verizon, PS Docket No. 07-114 at 2 (May 20, 2019) (“*Verizon Comments*”).

accuracy.”⁸ Although Sprint did not submit comments in response to the *Fourth FNPRM*, T-Mobile did file comments that refrained from expressly opposing the Commission’s 3 meter metric proposal, explaining instead that it “supports the Commission’s efforts to incent all providers to improve the provision of location information for emergency calls from wireless callers.”⁹

The incentives that will result from the Commission’s adoption of a 3 meter metric will ensure that the vertical location information that is provided to emergency first responders will quickly achieve 3 meter accuracy and rapidly improve beyond that. As CTIA observed, “[a]s vertical location technologies continue to evolve, CTIA expects that wireless providers will seek out and evaluate through testing any technology solutions that can provide the public safety community with the most accurate, actionable location information with wireless 9-1-1 calls.”¹⁰ Public safety organizations share this view, explaining that “one would expect the accuracy of vertical location systems to improve as they are deployed “at scale” and additional experience with them is gained.”¹¹ This is consistent with NextNav’s own assurance that it will “provide wireless carriers and the public safety community the highest degree of accuracy possible regardless of whether the FCC metric is established at 3 meters.”¹²

Given this consensus view, the Commission should adopt its proposed 3 meter metric and thereafter monitor continued improvements in vertical location accuracy to determine whether

⁸ Comments of CTIA, PS Docket No. 07-114, at 9 (May 20, 2019) (“*CTIA Comments*”).

⁹ Comments of T-Mobile USA, Inc., PS Docket No. 07-114 at 1-2 (May 20, 2019) (“*T-Mobile Comments*”).

¹⁰ *CTIA Comments* at 10.

¹¹ *BRETSA Comments* at unnumbered page 4.

¹² Comments of NextNav, LLC, PS Docket No. 07-114, at 7 (May 20, 2019) (“*NextNav Comments*”).

market forces will be sufficient to tighten the accuracy of vertical location services beyond 3 meters, or whether the Commission’s metric should be further tightened, as recommended by some public safety organizations.¹³

II. A 3 METER VERTICAL METRIC HAS BEEN REPEATEDLY DEMONSTRATED TO BE TECHNICALLY ACHIEVABLE BY LOCATION VENDORS

Although CTIA expressed support for the adoption of a 3 meter vertical metric, CTIA argues that “no z-axis solutions capable of meeting 3 meter accuracy have been validated.”¹⁴ CTIA’s assertion is contradicted by the Stage Z Report that was prepared with the cooperation of the wireless carriers. The report expressly concluded that the “bottom-line performance” demonstrated by NextNav’s location technically was a “vertical error of 1.8 meters or less” for 80 percent of wireless fixes.¹⁵ Thus, although the report identified further testing that might be conducted, the report clearly validated the highly accurate performance capabilities of NextNav’s vertical location technology. The Stage Z report also mirrored the results of prior independently conducted test beds in which NextNav’s vertical location technology produced very consistent levels of accuracy.

Despite these facts, several parties persist in arguing that further testing is needed before a 3 meter z-axis metric should be adopted. T-Mobile argued that more development and testing is needed “particularly in the most challenging urban and dense urban settings where they are most

¹³ See *Texas 9-1-1 Entities Comments* at 2 (arguing that the z-axis metric must ultimately evolve to being within plus or minus 1 meter to mitigate ‘floor level’ issues”); *Public Safety Comments* at 3 (explaining that the Commission “should consider narrowing the z-axis metric in five years’ time, when technology has advanced”).

¹⁴ See *CTIA Comments* at 5.

¹⁵ See *Report on Stage Z*, 911 Location Test Bed, LLC PS Docket 07-114, at 120 (Aug. 3, 2018) (“*Stage Z Report*”).

helpful.”¹⁶ NextNav’s Stage Z results, however, were particularly strong in urban and dense urban morphologies, demonstrating 1.5 meter and 2 meter accuracy, respectively, for 80 percent of wireless calls.¹⁷

Qualcomm also argued for more testing, claiming there are “uncertainties and a potential for increased errors due to various air pressure phenomena, such as the stack effect and associated positive and negative in-building pressurization.”¹⁸ These issues, however, were discussed extensively in the Stage Z report, which observed that “a cyclic temporal variation on the order of +/- 1 meter is apparent over a period of 24 hours.”¹⁹ Importantly, these 1 meter variations were largely incorporated in the 1.8 meter accuracy that was demonstrated for NextNav’s vertical location technology in the Stage Z test bed meaning that, absent these variations, NextNav’s test results might have been even better. Therefore, although further testing on these conditions might be beneficial, such testing is not required for establishing an initial z-axis metric.

Both Qualcomm and CTIA further argue that vertical location solutions that can meet the 3 meter metric are not yet commercially available,²⁰ with CTIA claiming that these vertical location solutions “are not similarly commercially and widely available today on the scale that horizontal location solutions were available back in 2015.”²¹ In reality, none of the location

¹⁶ *T-Mobile Comments* at 3-4.

¹⁷ *Stage Z Report* at 64.

¹⁸ Comments of Qualcomm Incorporated, PS Docket No. 07-114, at 6-7 (May 20, 2019) (“*Qualcomm Comments*”).

¹⁹ *Stage Z Report* at 103.

²⁰ *Qualcomm Comments* at 4, 7-9.

²¹ *CTIA Comments* at 5.

technologies that were tested for horizontal accuracy prior to the Commission’s 2015 adoption of its *Third Report and Order* succeeded in demonstrating compliance with a 50 meter metric in a CSRIC test bed.²² In contrast, NextNav has clearly demonstrated the capability of its vertical technology to meet a z-axis standard of 3 meters and Polaris has explained how its technology can achieve within 3 meter results as well.²³ Further, NextNav can complete deployment of its z-axis technology in the top 50 cellular market areas (“CMAs”) by the 2021 and 2023 deadlines. Therefore, Qualcomm and CTIA’s concerns should be disregarded.

Qualcomm further argues that any vertical location technology that is employed by wireless carriers should be standardized, to make it “transparent, testable, and capable of deployment across all mobile handset OEMs” and so that it can be “economically implemented by a multitude of technology implementers.”²⁴ As acknowledged by both the Commission²⁵ and Verizon,²⁶ however, extensive standardization work on vertical location solutions has already been completed. Technical Specification 36.355 was prepared by 3GPP, which details the manner in which the vertical location data is processed between an end user handset and the Enhanced

²² See generally CSRIC III Working Group 3, Indoor Location Test Bed Report, at 27, Table 7.2-1 (Mar. 14, 2013), available at http://transition.fcc.gov/bureaus/pshs/advisory/csric3/CSRIC_III_WG3_Report_March_%202013_ILTestBedReport.pdf (last visited June 12, 2019) (showing tested horizontal accuracy in meters).

²³ See *Stage Z Report* at 133-134 (separate statement of Polaris Wireless).

²⁴ *Qualcomm Comments* at 6 and 8.

²⁵ See *NPRM*, ¶ 26.

²⁶ *Verizon Comments* at 5 (explaining that “[s]ome standards work is already complete (the LPP/LPPE interface), and other work is under way to address how service providers will format and deliver Z-axis information to PSAPs”).

Serving Mobile Location Center and transmitted through a carrier's LTE or 5G wireless network in a usable format.

Qualcomm further suggests that the manner in which location service vendors calibrate the barometric pressure sensors should also be standardized.²⁷ As Qualcomm is fully aware, standardization of components typically occurs when different systems interact. Thus, within the 3GPP process, the transmission of global positioning system ("GPS")-based location information is standardized, but the algorithms that are used to compute the location are not standardized. Those techniques are what each company uniquely develops to meet the appropriate performance thresholds and are the incentive for the companies to develop their best in class solutions. Further, as demonstrated in the 2018 CTIA test bed, the NextNav sensor calibration software is already developed and ready to be incorporated into handsets without further delay.

In summary, vertical location technologies that can reliably achieve 3 meter accuracy have already been developed, thoroughly validated, and can be made commercially available in the top 25 CMAs by April 2021 and in the top 50 CMAs by April 2023. The Commission should therefore facilitate this deployment by immediately adopting a vertical location metric of +/-3 meters and incorporating this requirement in its rules.

III. THE COMMISSION SHOULD NOT DELAY OR RELAX ITS VERTICAL LOCATION REQUIREMENTS WHILE ADDITIONAL TECHNOLOGIES ARE DEVELOPED

In addition to the vertical location technologies that have already been verified to achieve highly accurate z-axis information, other vertical location technologies are being developed, some of them by major players in the communications industry. For example, Google filed comments

²⁷ *Qualcomm Comments* at 6-8.

highlighting its work on the Android Emergency Location Service.²⁸ Qualcomm also explained that it is “working on enhancing location accuracy through hybrid systems that take advantage of the latest mobile handset and network capabilities.”²⁹ In addition, T-Mobile reported that it has incorporated “commercial location technologies from both Apple and Google into its E911 services.”³⁰ Startup companies are also seeking to develop highly accurate wireless location capabilities.³¹

The Commission should not, however, delay the implementation of vertical location technologies while these and other companies complete their development work.³² Even Google opposed a delay in the implementation timeline, acknowledging the potential harms of “delaying the delivery of potentially life-saving vertical location data into first responders’ hands.”³³ Or, as compellingly expressed by BRETSA,

How many have perished while waiting for First Responders to locate them over the years that vertical locations systems have been tested and shown consistent and improving results? How many more will needlessly perish while waiting to be found if we dither with the further testing CTIA urges?³⁴

²⁸ Comments of Google LLC, PS Docket No. 07-114, at 1 (May 20, 2019) (“*Google Comments*”).

²⁹ *Qualcomm Comments* at 2.

³⁰ *T-Mobile Comments* at 1.

³¹ See, e.g., Comments of Precision Broadband LLC, PS Docket No. 07-114 (May 20, 2019) (“*Precision Broadband Comments*”).

³² See *Qualcomm Comments* at 2 (urging the Commission to delay the adoption of a 3 meter vertical location requirement).

³³ *Google Comments* at 14.

³⁴ *BRETSA Comments* at 2.

Not only would further delay pose a continued risk to public safety, but it is also unclear whether it would appreciably improve the information that is currently available to the Commission. Although the wireless carriers have scheduled a second round of vertical location tests, companies planning to participate in those tests have not suggested that they will break significant new ground. Google, for example, explained that “[t]he Commission should not presume that the upcoming Stage Za testbed will necessarily resolve all issues with verifying z-axis reporting capability.”³⁵

The Commission should also reject requests to relax the proposed 3 meter vertical location requirement.³⁶ In considering this issue, it is essential to note that the quantification of the vertical location requirement is not simply a matter of compromise or ‘splitting the baby in half.’ Instead, a vertical metric of 3 meters is critical because a more lenient requirement of either 4 or 5 meters³⁷ would invalidate the important presumption of ‘floor level’ accuracy.

Although floor to ceiling heights in tall buildings vary widely, they are rarely below 8 feet in the United States and average around 9 to 10 feet in height. Another 3 to 4 feet per story can be attributed to building structure and utility spaces. As a result, building story heights in the United States generally range from 11 to 14 feet between stories.

Coupled with this is the reasonable assumption that a significant portion of callers to E911 emergency services that are unable to verbally convey their location data may be lying on the floor either because they are incapacitated, avoiding smoke or hiding from an assailant. Thus, if one assumes that the center point of a +/-3 meter vertical fix is at or near the floor, then the highest

³⁵ *Google Comments* at 2.

³⁶ *See id.* at 6-7.

³⁷ *See id.* at 10 (advocating in favor of a 4 meter vertical location accuracy requirement).

point above the center point will still be on the same story and the lowest point will be in the story below, but well above the level of the floor. Accordingly, employing this reasonable assumption, a vertical location metric of 3 meters provides a very strong indicator of the precise floor on which a caller is located.

In contrast, a vertical location metric that exceeds 3 meters, even by one meter, undercuts this assumption because any vertical location fix that is provided to emergency personnel could reasonably indicate any one of the three stories, including lying on the floor in any one of these three stories. Therefore, the Commission should refrain from considering any proposed compromise to its 3 meter accuracy proposal and instead should require wireless carriers to provide vertical location information that is accurate within no more than 3 meters.

IV. THE COMMISSION SHOULD ADOPT REASONABLE MEASURES TO ENSURE COMPLIANCE WITH ITS PROPOSED 3 METER VERTICAL METRIC

The *Fourth FNPRM* raises a number of implementation questions regarding the Commission's proposed 3 meter metric, some of which were not fully resolved in the *Third Report and Order*. For example, the Commission seeks comment on the manner in which carriers must demonstrate compliance with the 3 meter metric and the universe of handsets that would be subject to this requirement. Also unaddressed was the format in which vertical location data must be reported. In each case, the Commission should require adherence with reasonable measures that will best serve the public safety needs of wireless callers to E911 emergency services.

A. Nearly All Parties Agree on Applying Vertical Location Compliance Requirements to 80% of Calls From Z-axis Capable Handsets as Demonstrated in a Test Bed

As the *NPRM* acknowledges, barometric pressure sensors have become widely deployed in smartphones, and software to calibrate the sensors could be uploaded to older smartphones using

over-the-air updates.³⁸ Further, as CTIA explains, “consumer demand for innovative location solutions, such as z-axis, will create the appropriate incentives to ensure devices with z-axis capabilities are increasingly and widely available to consumers calling 9-1-1.”³⁹ Therefore, based on market forces alone, it can reasonably be expected that the universe of wireless phones that can comply with a 3 meter vertical location metric will be large and continue to increase rapidly.

To ensure the required widespread availability of these phones is ultimately realized, the Commission might consider establishing a required percentage of new handsets sold (or phone operating systems upgraded) for use on each of the wireless carriers’ networks as of the 2021 and 2023 milestone dates that must be z-axis capable. Provided significantly large percentages of new phones and operating systems are shown to be z-axis capable, then carrier compliance with the 3 meter metric should be tied solely to z-axis capable handsets and not to all wireless phones regardless of their vintage. Additionally, the Commission might provide a safe-harbor for any carrier showing 80% of live E911 calls in the monitored markets delivered with vertical location information using technologies that have proven 3 meter accuracy in an independent test bed.

Wireless carriers should be permitted to demonstrate compliance with these requirements using the results of independently managed z-axis test beds and by certifying that the technologies deployed in their wireless networks are the same as those that were verified in the test bed. This

³⁸ See *NPRM*, ¶ 26.

³⁹ *CTIA Comments* at 7.

approach has wide support both among wireless carriers⁴⁰ and location technology vendors.⁴¹ As AT&T explained, “[c]arriers should be able to show compliance by 1) validating the technology in the CTIA Test Bed; 2) deploying the technology consistent with such testing, and 3) asserting that they are in compliance with the Commission’s 2021 and 2023 benchmarks from the *Fourth Report & Order*.”⁴² CTIA and T-Mobile advocated in favor of this same approach.⁴³

Of course, the use of test beds for compliance would not ameliorate the Commission’s preexisting requirement that carriers provide aggregate live call data for the six identified test cities. This reporting requirement should address the concerns of public safety organizations such as BRETSA, which argued in its comments that wireless carriers should be required to “conduct and file proofs-of-performance of vertical location technology as deployed, and provide test procedures for First Responders to determine vertical location accuracy within their response

⁴⁰ See *AT&T Comments* at 3 (*emphasis in original*) (arguing that “[t]o ensure that the new standard is clear and achievable, the Commission should revise the z-axis metric in proposed rule 20.18 to read: ‘within 3 meters above or below (plus or minus 3 meters) the handset for 80% of all wireless E911 calls made from z-axis capable devices.’”); *Verizon Comments* at 3 (explaining that “[r]eliance on the test bed performance of capable devices also enables service providers to phase in capable handsets in a manner consistent with the Commission’s longstanding approach to handset-based solutions generally”).

⁴¹ *Qualcomm Comments* at 6 (asserting that “[w]ere the Commission to adopt a z-axis metric based upon the performance of barometric pressure sensors, the agency should apply that metric to only those handsets so equipped.”)

⁴² *AT&T Comments* at 3.

⁴³ *CTIA Comments* at 8 (explaining that “the Test Bed would validate that a given technology solution can meet the proposed z-axis metric of ± 3 meters for 80 percent of indoor wireless calls in the Test Bed, and a wireless provider would then certify that the z-axis technology in its network is deployed consistently with how it was tested in the Test Bed and that it covers 80 percent of the population of the top 25 CMAs and the top 50 CMAs in the applicable timeframes”); *T-Mobile Comments* at 2 (requesting that the Commission “require carriers to meet the specified accuracy metric for 80 percent of test calls collected in the Test Bed, rather than for 80 percent of all indoor wireless 911 calls”).

areas.⁴⁴ Obviously, such additional measures might be beneficial, but the actual determination of regulatory compliance should be based solely on the results of the test beds using z-axis capable phones.

B. The Commission Should Require Compliance with the Z-Axis Metric Using the Most Accurate and Reliable Reporting Method Possible, Which is Height Above Ellipsoid

A clear consensus has been expressed that vertical location data should be delivered to PSAPs as a quantitative value expressed as height above ellipsoid (“HAE”).⁴⁵ As ATIS explained, “to ensure that PSAPs can convert location information to the format that best suits their needs, a baseline requirement would be to deliver this information as height above ellipsoid per World Geodetic System 1984 (WGS-84) datum.”⁴⁶ NENA further explained that “[b]ecause HAE is the globally recognized standard for delivering z-axis information, NENA believes that it is the sole z-axis representation that should be required by the Commission’s rules.”⁴⁷ Although other options were discussed in the *NPRM* and in various comments, none of them achieved a consensus of support or provided the technological lineage as HAE, which is already used for the global positioning system.

⁴⁴ *BRETSA Comments* at unnumbered page 5.

⁴⁵ See, e.g., *Texas E-9-1-1 Entities Comments* at 4 (explaining that as 9-1-1 systems and PSAPs nationwide transition from existing 2D GIS towards 3D GIS, a standardized methodology for conveyance of z-axis information appears critical and it should be aligned with GPS in using height above ellipsoid); *T-Mobile Comments* at 12 (expressing support for an HAE approach, explaining that “[h]aving a commonly defined reference system for altitude estimates is essential to allow PSAPs to prepare for receiving and efficiently utilizing altitude information in association with 911 calls”).

⁴⁶ Comments of the Alliance for Telecommunications Industry Solutions, PS Docket No. 07-114, at 4 (May 20, 2019) (“*ATIS Comments*”).

⁴⁷ *NENA Comments* at 3.

The Commission should reject proposals to require wireless carriers and their location vendors to convert numeric vertical location data into floor level information. APCO claimed that such conversion is “technically feasible today”,⁴⁸ but of the four technical sources APCO cites as evidence, none come even close to establishing the technical feasibility, particularly in light of the upcoming 2021 and 2023 milestones. Two of the citations reference trade press reports on T-Mobile and Verizon’s deployments of 5G small cells,⁴⁹ but neither carrier asserts in any way that small cell densification results in floor-level location determination. One of the citations references an academic article using barometric and other sensors to project temporary floor location (but not floor number) within a large building provided the person enters the building at street level and that transition is clearly detectable through a reduction in GPS reception, and the person does not subsequently pass near a window with significant visibility of GPS satellites.⁵⁰ The final source is the website of Carbyne LTD, a company purporting to “correctly map out indoor locations down to a few feet”, using sensors in handsets, crowd sourcing, and triangulation of third party transmitters.⁵¹ Other than its website assertions, however, it does not appear the company has demonstrated any ability to accomplish this task, nor has it responded to any of the industry and CTIA test bed requests for vendors to demonstrate their capabilities.

⁴⁸ *APCO Comments* at 7.

⁴⁹ See *id.* at 6 n.22 (citing Mike Dano, *New T-Mobile’s plans for in-home, fixed wireless internet services begin to take shape*, Fierce Wireless (Sept. 21, 2018), <https://www.fiercewireless.com/5g/new-t-mobile-s-plans-for-home-fixed-wireless-internet-services-begin-to-take-shape>; 5G is Here, Verizon (Sept. 11, 2018), <https://www.verizon.com/about/news/5g-here>).

⁵⁰ See William Falcon & Henning Schulzrinne, *Predicting Floor Level for 911 Calls With Neural Networks and Smartphone Sensor Data* (2018), available at <https://arxiv.org/pdf/1710.11122.pdf> (last visited June 9, 2019).

⁵¹ See <https://carbyne911.com/the-indoor-imperative/> (last visited June 1, 2019).

In contrast, several parties explained that the conversion from HAE to a specific floor level is not currently possible, observing that “[a]n authoritative reference source for the number and height of floors in a given building does not currently exist” and therefore “it is not possible for existing systems to determine whether a particular floor-level location estimate is valid and trustworthy.”⁵² NENA further explained the substantial risks that would result from attempting to convert a numeric altitude reading into a potentially incorrect address or floor level value, observing that “[i]f that address is in any way incorrect, then it is potentially much more harmful than a geodetic location that has a low degree of precision.”⁵³ These complexities are real and not easily overcome, even with extensive investment of time and money. They certainly do not lend themselves to resolution within the compliance milestone timeframes that currently exist for z-axis location (2021/2023). Incremental progress towards this goal may best be facilitated by an industry-wide cooperative forum such as the Communications Security, Reliability and Interoperability Council (“CSRIC”).

The Commission should therefore require wireless carriers to report vertical location information in the globally accepted HAE format because it ensures a much higher degree of accuracy and it can be incorporated with existing location data that is provided to first responders using GPS and other means. Further, as requested by NENA, the reported data should be made available in Location Object format and expressed as a geodetic Location Object in order to support its use by PSAPs operating with both legacy and next generation dispatch technologies.⁵⁴

⁵² *Id.* at 5; *see also Google Comments* at 11 (explaining that “[t]he user’s height within a building is not a proxy for floor number, because floors may differ in height within a building or from building to building”).

⁵³ *NENA Comments* at 15.

⁵⁴ *See id.* at 6-7.

C. The Commission Should Give Carriers the Option to Deploy Vertical Location Technologies Covering 80% of Large Buildings Rather than 80% of the Population

In its comments, NextNav raised the possibility that the Commission should give additional thought to its coverage requirements for vertical location technology, such as allowing wireless carriers to deploy these capabilities for 80% of buildings that exceed three stories.⁵⁵ Coincidentally, Verizon made a similar recommendation in its comments, urging the Commission to permit carriers to “refine the per-CMA requirement” to enable service providers to target deployment of network-level capabilities in areas where multi-story buildings are concentrated. As Verizon correctly observed, “the Commission’s public safety objectives would not be served if deployment of the capability in a suburban area helps achieve the 80 percent coverage benchmark, but the result is that Z-axis coverage is provided for single-story residential dwellings, rather than the multi-story buildings where those residents work (but do not live).”⁵⁶ The Commission should consider how best to achieve this flexibility as quickly as possible given that the vertical location deadlines are rapidly approaching.

V. THE COMMISSION SHOULD REJECT CALLS TO RELY SOLELY ON THE DISPATCHABLE LOCATION APPROACH

APCO is alone in arguing that the Commission should refrain from adopting a vertical location metric in favor of sole reliance on the dispatchable location approach.⁵⁷ APCO is also

⁵⁵ *NextNav Comments* at 19.

⁵⁶ *Verizon Comments* at 5.

⁵⁷ Comments of APCO International, PS Docket No. 07-114, at 1 (May 20, 2019) (“*APCO Comments*”).

alone in claiming that “[d]ispatchable location technologies have been demonstrated to be viable.”⁵⁸

The Commission’s *Thirds Report and Order* appropriately reflected a flexible and technically neutral approach in which wireless carriers were given the option between compliance with horizontal and vertical location requirements or a dispatchable location approach. Given the proximity of the first compliance deadline, it would be arbitrary and capricious for the Commission to now withdraw one of the two options for vertical location compliance. Such action would also be highly imprudent given the very disappointing vertical location accuracy test results that were documented by ATIS for the dispatchable location approach using the National Emergency Address Database.

A number of parties raised concerns about the disappointing NEAD test results.⁵⁹ The most detailed critique was filed by NENA, which concluded that the NEAD “lacks the reference point density and is prone to gross location errors, such as successfully delivering an improper address.”⁶⁰ The lack of sufficient reference point density was highlighted by ATIS in its NEAD Test Report, which explained that “[b]y extrapolating from the buildings in this test campaign – none of which achieved 100% DL2/DL1 Accurate Percentage – a trend emerges that suggests an acceptable Provisioning Density could be somewhere in the 50% to 75% range for medium and large commercial and residential structures.”⁶¹ It is important to note that the NEAD density

⁵⁸ *Id.* at 5.

⁵⁹ See *Texas 9-1-1 Entities Comments* at 6; *Qualcomm Comments* at 5 (indicating that the NEAD database “will need additional accurate data in order for this solution to be viable in all regions and morphologies”).

⁶⁰ *NENA Comments* at 22-24.

⁶¹ *E911 Location Test Bed Dispatchable Location Summary Report*, ATIS Test Bed Program Management, at 19 (April 2019) (“*NEAD Test Report*”) (vaguely defining Provisioning Density

overall in the two test cities was already at 14% and 19% of the population⁶² (*i.e.*, approaching the Commission’s 25% compliance objective), but the test bed was still unable to select random test buildings as they did in prior tests due to the lack of sufficient reference points in numerous buildings.⁶³ The NEAD Test Report asserts that the test results were therefore overly positive by some unknown amount.⁶⁴ Although we agree it is impossible to accurately project the amount of over-statement inherent in the test results, the scatter-plot of tested buildings compared to associated reference point densities,⁶⁵ suggests that the tested building densities may already be well above the Commission’s 25% density objective, thus calling into question the fundamental validity of the objective itself.

Given the substantial problems with the NEAD, the two major cable operators recommended that it be abandoned, observing that “a continued focus on a NEAD-based system could detract from the widespread implementation of innovative and likely more effective location technologies.”⁶⁶ Further, the test report itself notes that additional reference points provided by cable operators, while increasing the overall density versus population percentage, would tend to

as “the fraction of units (apartments, suites, separate rooms or partitions) in a building in which one or more reference points are provisioned in the NEAD”).

⁶² *See id.* at 19.

⁶³ *See id.* at 3 (explaining that a total of 40 buildings were identified as suitable to be used in the tests, but “[d]ue to the limitations in the provisioning of the NEAD, only a subset of 25 buildings – 13 in San Francisco and 12 in Atlanta – were feasible” for testing).

⁶⁴ *See id.* at 7.

⁶⁵ *See id.* at 19, Figure 5-5.

⁶⁶ Letter from Catherine Bohigian, Executive Vice President, Government Affairs, Charter Communications and Kathryn A. Zachem, Executive Vice President, Regulatory and State Legislative Affairs, Comcast Corporation, to Marlene H. Dortch, Secretary, Federal Communications Commission, PS Docket No. 07-114, at 1 (May 24, 2019).

improve performance in residential and suburban locations where it is less important, but not necessarily in the problematic multi-story office structures in urban and dense urban environments.⁶⁷

In contrast, APCO urged the Commission to require the wireless carriers to focus solely on the NEAD. In taking this position, APCO expressed a number of criticisms regarding the 3 meter z-axis option, each of which is addressed below.⁶⁸ First, APCO claimed that the only way first responders could operationally use numeric vertical location information is if emergency personnel used their own devices to match the altitude of the wireless caller.⁶⁹ APCO claimed that this would increase the variability of the fix beyond 3 meters because of potential differences between the barometric sensors used by emergency personnel as compared to the wireless caller and potential differences in the calibration source.⁷⁰

This argument disregards a primary finding of CTIA's Z-Axis Report as it related to NextNav's test results across the variety of different handsets and sensors tested. Even at the 90th percentile, the difference in accuracy between the best and worst performing handsets was less

⁶⁷ See *id.* at 21 (recommending that, in seeking to increase the number and density of NEAD reference points, “[p]ay close attention to commercial and civic buildings, such as hotels, stadiums, museums, and mid/high-rise commercial structures, as these may benefit less from the next likely source: cable-company-provided Reference Points”).

⁶⁸ APCO also claimed incorrectly that the Commission does not have the authority to adopt a z-axis proposal other than +/-5 meters. See *APCO Comments* at 6. Although it is unclear whether the Public Safety and Homeland Security Bureau could have adopted a 3 meter metric on delegated authority, the full Commission has now adopted a *Fourth FNPRM* proposing the adoption of a 3 meter metric. The Commission can therefore adopt whatever metric is supported by the record for the *Fourth FNPRM*, regardless of the Commission's prior findings in its *Third Report and Order*.

⁶⁹ *APCO Comments* at 3

⁷⁰ See *id.*

than a meter (2.1 meter versus 2.7 meter accuracy).⁷¹ The preponderance of variability came from environmental factors that were unrelated to the devices employed, including weather conditions, temperature, building HVAC and stack effect, as well as the distance from and accuracy of nearby barometric reference points. A subtle but extraordinarily important implication of this fact is that as first responders enter the same building as a wireless caller, particularly as they ascend closer to the same floor, these external variabilities *disappear* (since they impact both the caller's device and the first responder's device in an identical manner). This is crucial from a practical and operational standpoint because the certainty that the first responder is on the same floor as the victim becomes extremely high (*i.e.*, the altitude *difference* between the two is more in the sub-meter range even with a deviation from "ground truth" of 3 meters). This sub-meter differential between the calculated altitude of the first responder and the victim helps explain the operational success in reduced search time experienced by IAFF personnel during their 2014 field trials in San Francisco.⁷²

Second, APCO argued that the Commission's rules lack any requirement for the provision of confidence and uncertainty ("C/U") data for z-axis location information,⁷³ while noting that the Commission's rules require a uniform confidence level of 90% for horizontal location information.⁷⁴ NextNav agrees with APCO that this oversight should be remedied. The Commission should modify Sections 20.18(j) and 20.18(j)(3) of its rules to include z-axis data in

⁷¹ See *Z-Axis Report* at 66, Table 9-2.

⁷² See *IAFF Comments* at 2-3

⁷³ See *id.* at 4.

⁷⁴ See *id.* (citing 47 C.F.R. § 20.18(j)).

its requirements for C/U data on a per call basis at the request of the public safety answering points (“PSAPs”).

Third, APCO raises an enforcement and technology neutrality concern regarding whether the Commission’s z-axis accuracy requirement applies only to calls from phones that contain a barometric pressure sensor, and whether such a requirement would constitute a technology-neutral rule. As a foundational matter, since the Commission rules already allow carriers to comply with z-axis requirements through the use of dispatchable location technologies such as the NEAD, any rule establishing an altitude accuracy metric of 3 meters simply provides an alternative technical approach to meeting the obligation, and therefore is consistent with the Commission’s practice of technology neutrality. Further, although using barometric pressure sensors to establish a caller’s altitude has proven to be a low-cost and effective technique, it is clear that other technologies are under development and may well meet a 3 meter accuracy standard,⁷⁵ thus meaning that a z-axis capable handset may not exclusively mean one containing a barometric pressure sensor and associated software. As the Commission did with its horizontal accuracy requirements, the specific vertical accuracy metric need not restrict carriers and location vendors in any technical approach they deem effective to meet the metric.

⁷⁵ See, e.g., *Google Comments* at 1 (highlighting its work on its Android Emergency Location Service); *Qualcomm Comments* at 2 (explaining that it is “working on enhancing location accuracy through hybrid systems that take advantage of the latest mobile handset and network capabilities); *T-Mobile Comments* at 1 (noting that it is working with both Google and Apple on wireless location technologies); *Precision Broadband Comments* at 1 (discussing the technologies that it is developing).

VI. PRIVACY REQUIREMENTS SHOULD BE IMPOSED SOLELY ON Z-AXIS DATA PRODUCED TO SUPPORT CALLS TO E911 EMERGENCY SERVICES

In adopting privacy rules for vertical location information, the Commission should recognize that such data can be produced in two contexts. First, it can be produced by a wireless handset to support a call to E911 emergency services, in which case it is transmitted automatically without consultation with the handset user.⁷⁶ Second, it could be produced in a non-emergency situation to support some other handset application, but only if the handset user has given their specific approval in the handset settings for their location data to be used in this manner.

NextNav acknowledges that the Commission's enhanced privacy requirements should be applied to the former case, but not to the latter. Instead, handset users should continue to have the option to permit the applications they have downloaded onto their smartphones to use vertical location data for whatever beneficial purposes the handset user desires, just as they do today with respect to location data produced by GPS and other means.

Other commenters expressed support for this approach. For example, CTIA acknowledged that "location information *derived from wireless 9-1-1 calls*, including z-axis location data, should be used only for 9-1-1 purposes, except as otherwise required by law."⁷⁷ AT&T further explained that such an approach is consistent with currently accepted practices in that "[t]oday, the horizontal location information (x- and y-axis data) collected for *individual 911 calls* is used exclusively for responding to emergency calls, or for responding to valid law enforcement requests for the information."⁷⁸

⁷⁶ See 47 U.S.C. § 222(d)(4)(A) (providing that a telecommunications carrier may provide call location information concerning the wireless user to support emergency response).

⁷⁷ CTIA Comments at 10 (*emphasis added*).

⁷⁸ AT&T Comments at 4 (*emphasis added*).

The appropriate treatment for vertical location information that is generated with the user's consent in a non-emergency situation is fundamentally different than the privacy measures that are appropriate to protect the individual address data contained in the NEAD, the latter of which is outside the control (and, in some cases, the knowledge) of the individual in question. Further, the Commission was justified in requiring that the NEAD be used only to produce location information for emergency response and for no other purposes. The development of the NEAD, after all, was authorized by the Commission specifically for the purpose of public safety.

In contrast, barometric pressure sensors were originally incorporated in smartphones for non-emergency purposes, including to support personal fitness and mapping applications and other programs that are desired by end users. Thus, although recent technical improvements to the accuracy of these sensors were developed to address the vertical location requirements of emergency first responders, the location data that these capabilities produce in non-emergency situations should still be available to consumers that desire and consent to their beneficial use.

VII. CONCLUSION

NextNav supports the Commission's proposal to adopt a vertical location metric of +/-3 meters for 80% of wireless calls to E911 emergency services using z-axis capable handsets. Given the overwhelming support for this proposal that was expressed in the comments that were filed in response to the Commission's *Fourth FNPRM*, the Commission should immediately adopt this

requirement in order to ensure that it can be implemented by the major wireless carriers in the top 25 CMAs by April 2021 and in the top 50 CMAs by April 2023.

Respectfully submitted,

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